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THE FEEDING VALUE OF RAISINS AND DAIRY BY-PRODUCTS FOR GROWING AND FATTENING SWINE

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E. H. HUGHES¹

INTRODUCTION

With the idea of utilizing the supply of low-grade raisins and making available a feed for pork producers, experiments to determine the value of cull raisins as a feed for swine were carried out by the Division of Animal Husbandry. That raisins have a possibility for this purpose is shown by the following chemical analysis: moisture 12.26 per cent; ash 2.22 per cent; crude protein 3.63 per cent; crude fiber 6.67 per cent; nitrogen-free extract 11.61 per cent; fat 1.30 per cent; total sugar 62.31 per cent.

Information on the value of raisins as a swine feed is very limited. In 1916 Thompson and Voorhies of this station² fed one lot of pigs equal parts of rolled barley and raisins with alfalfa meal in the proportion of five pounds of the mixture to one pound of the meal. Another lot received raisins and alfalfa meal in equal proportions. The ration fed the first lot gave the better results: Here 2.97 pounds of raisins had a feeding value equal to 2.66 pounds of barley. In the second ration, raisins were not so efficient, since 11.13 pounds were required to equal 5.63 pounds of barley. Moreover, it was difficult to keep the pigs on feed with this ration, and they scoured severely at times.

Data concerning the value of certain dairy by-products as protein supplements to barley and to other carbonaceous concentrates were also obtained. The dairy by-products studied were skim milk, buttermilk, whey, condensed skim milk, and condensed whey.

Five experiments were conducted at the California Experiment Station during the years 1923 and 1924, the results of which are reported in this publication.

¹ Associate Professor of Animal Husbandry and Associate Animal Husbandman in the Experiment Station.

² Thompson, J. I., and Edwin C. Voorhies. Hog feeding experiments. California Agr. Exp. Sta. Bul. 342:373-396. 1922.

FIRST TRIAL

This experiment was conducted to obtain information on the palatability of raisins and to determine their value as a carbohydrate feed for fattening pigs. This trial began on April 20, 1923, and closed on May 25. The feeding period was 35 days. The pigs, all of which had been farrowed during the fall of 1922, were divided into three lots of eight each.

Rations.—The rations fed were as follows:

Lot 1: rolled barley and tankage, fed in separate self-feeders.

Lot 2: rolled barley, raisins, and tankage fed in separate self-feeders.

Lot 3: rolled barley one part, raisins one part, skim milk three parts, by weight, hand fed three times daily.

Each lot of pigs had access to one-fourth of an acre of barley pasture. The pigs were taken off pasture while it was being irrigated, May 7 to May 9, inclusive.

Results.—While the results, as presented in table 1, are not conclusive, they indicate the apparent palatability of raisins as a swine feed. The rate of gain in lots 2 and 3, in which raisins constituted a part of the ration, was greater than that for the check lot fed barley and tankage. A comparison of the amount of feed for 100 pounds of gain in lots 1 and 2 shows that the former group consumed slightly less tankage than the latter, but that the 226.57 pounds of raisins fed lot 2 reduced materially the quantity of barley necessary for this amount of gain.

TABLE 1
SUMMARY OF RESULTS OF FIRST TRIAL

Lot No.	Ration	Average initial weight	Average final weight	Average daily gain	Feed consumed for 100 pounds of gain
1	Rolled barley	Pounds	Pounds	Pounds	{Rolled barley, 418.08 Tankage, 5.29
	Tankage.....		133.08	1.69	
2	Rolled barley	131.41	194.25	1.80	{Rolled barley, 240.89 Raisins, 226.57 Tankage, 12.93
	Raisins.....				
3	Tankage.....	135.42	210.84	2.15	{Rolled barley, 184.63 Raisins, 184.63 Skim milk, 1107.78
	Rolled barley				
	Raisins.....				
	Skim milk.....				

The pigs in lot 3 gained more rapidly than did those of either lots 1 or 2, and the amount of concentrates consumed was less than for either of the other lots. They did, however, consume a considerable quantity of skim milk, in addition to rolled barley and raisins.

SECOND TRIAL

The feeding period of the first trial was comparatively short and the results obtained were not conclusive. Additional information seemed necessary. In the second trial the Dairy Industry Division³ provided the dairy by-products used and the raisins were supplied by the Division of Viticulture and Fruit Products.

Nine lots of ten pigs each were used in this test. These pigs were farrowed in March and April, 1923, at the University Farm. They were divided as carefully as possible into uniform lots. The trial began June 5, 1923. Lots 4, 5, 6, 7, and 8 were discontinued earlier than the others because they gained more rapidly. Their final weights were taken September 11, 1923. The feeding period for these lots was therefore 98 days. Lots 1, 2, 3, and 9 were discontinued on September 25, 1923, making a feeding period of 112 days.

Rations.—The rations fed the various lots were as follows:

Lot 1: rolled barley, self fed.

Lot 2: rolled barley and tankage, self fed in separate feeders.

Lot 3: rolled barley, raisins, and tankage, self fed in separate feeders.

Lot 4: 1 part of rolled barley and 3 parts of skim milk by weight, hand-fed three times daily.

Lot 5: 1 part of rolled barley and 3 parts of whey, by weight, hand-fed three times daily.

Lot 6: 1 part of rolled barley and 0.75 part of condensed skim milk, by weight, hand fed three times daily.

Lot 7: 1 part of rolled barley and 0.75 part of condensed whey, by weight, hand fed three times daily.

Lot 8: $\frac{1}{2}$ part of rolled barley, $\frac{1}{2}$ part of raisins, and 3 parts of skim milk, by weight, hand fed three times daily.

Lot 9: $\frac{1}{2}$ part of rolled barley, $\frac{1}{2}$ part of raisins, and 3 parts of whey by weight, hand fed three times daily.

TABLE 2
COMPOSITION OF ROLLED BARLEY, CULL RAISINS, AND TANKAGE

Feeds	Moisture	Ash	Crude protein	Crude fiber	Nitrogen-free extract	Fat	Sucrose	Dextrose	Total sugar
Rolled barley....	10.20	2.68	10.69	7.37	66.47	2.59			
Tankage.....	5.43	27.06	48.07	1.41	0.03	18.00			
Cull raisins.....	12.26	2.22	3.63	6.67	11.61	1.30	1.66	60.65	62.31

³ G. D. Turnbow, of the Dairy Industry Division, and A. J. Winkler, of the Viticulture Division, cooperated in this trial. The author wishes to express his appreciation for their suggestions, advice, and help in this part of the investigation.

The skim milk, condensed skim milk, whey, and condensed whey, were fed sweet. These dairy by-products were obtained fresh each day from the University Creamery. The specific gravity, and the content of ash, protein, lactic acid, sugar, and total solids for the skim milk and whey fed were practically the same as the average for these feeds given by Henry and Morrison.⁴ The average of the total solids was 32 per cent for both the condensed skim milk and the condensed whey fed.

Results.—An examination of table 3 verifies the fact that the addition of a nitrogenous concentrate or a dairy by-product to a barley ration increases the rate of gain. Lot 1, fed rolled barley, gained less than half as fast as did the other lots. The pigs in lots 2 and 3, fed tankage with barley in the first case, and barley and raisins in the second, consumed an excessive amount of tankage. That used in this test was of low grade, having a guaranteed protein content of only 45 per cent. The addition of raisins to a barley and tankage ration increased the average daily gain; the amount of feed required for 100 pounds of gain, however, was increased.

TABLE 3
SUMMARY OF RESULTS OF SECOND TRIAL

Lot No.	Rations	Feeding period (days)	Average initial weight	Average final weight	Average daily gain	Feed consumed for 100 lbs. of gain
1	Rolled barley*.....	112	Pounds 47.87	Pounds 97.92	Pounds 0.447	Barley, 562.32 Barley, 369.24
	Rolled barley.....					
2	Tankage.....	112	51.4	160.89	0.978	Tankage, 70.84 Barley, 227.77
	Rolled barley.....					
3	Raisins.....	112	52.0	175.3	1.101	Raisins, 137.83 Tankage, 97.02
	Tankage.....					
4	Rolled barley.....	†	54.33	212.20	1.611	Barley, 280.48 Milk, 841.45
	Skim milk.....					
5	Rolled barley.....	†	53.53	190.81	1.401	Barley, 331.40 Whey, 994.19
	Whey.....					
6	Condensed skim milk.....	†	54.8	191.47	1.395	Barley, 306.65 Milk, 230.02
	Rolled barley.....					
7	Condensed whey.....	†	52.87	185.4	1.352	Barley, 321.51 Whey, 241.13
	Rolled barley.....					
8	Raisins.....	†	54.53	198.29	1.467	Barley, 156.08 Raisins, 156.08
	Skim milk.....					
	Rolled barley.....					
9	Raisins.....	†	54.07	170.8	1.042	Barley, 195.24 Raisins, 194.81
	Whey.....					

* Self-fed. † Hand-fed three times daily.

⁴ Henry, W. A., and F. B. Morrison. Feeds and feeding, A handbook for the student and stockman. Appendix I, p. 709-721. Henry-Morrison Company, Madison, Wisconsin. 1923.

With the exception of lot 9, which was fed barley, raisins, and whey, the pigs given a dairy by-product gained more rapidly than did those in lots 1, 2, or 3. When raisins were added to a ration of barley and skim milk or barley and whey (lots 4 and 5 and lots 8 and 9), the amount of feed required for 100 pounds of gain was increased. The addition of raisins also reduced the rate of gain. However, the pigs in lot 8 made gains of nearly one and one-half pounds per head daily, and the total feed consumed for 100 pounds of gain was not much greater than that for lot 4. Lot 9 consumed considerably more feed for 100 pounds of gain than lot 5.

A comparison of lot 4 (fed barley and skim milk), and lot 5 (fed barley and whey), with lot 6 (fed barley and condensed skim milk) and lot 7 (fed barley and condensed whey), indicates more rapid gains in those fed skim milk and whey. The feeding of barley and skim milk resulted in more efficient gains than the feeding of barley and condensed skim milk.

When the cost of condensing was added to the original cost of skim milk and whey, the gains made by the pigs fed the condensed products were more expensive.

THIRD TRIAL

The raisins fed in the third, fourth, and fifth trials were furnished by the Sun-Maid Raisin Growers' Association and had the following average composition: moisture 15.70 per cent; ash 2.67 per cent; protein 3.06 per cent; crude fiber 1.20 per cent; sugar 70.70 per cent; other carbohydrates and acid 5.66 per cent; and fat 1.01 per cent.

This trial began January 23, 1924, and closed April 2. The feeding period was 70 days. There were five lots of 10 pigs each, and one, lot 6, of only 9. These pigs were farrowed in September and October, 1923. One pig was removed from lot 9 at the end of the first week and was disregarded from the first. All were fed in dry lot. During the month of March it became necessary to discontinue feeding skim milk and butter milk. For a time tankage was substituted in lots 2, 4, 5, and 6.

Rations.—The rations fed were as follows:

- Lot 1: rolled barley and tankage self fed.
- Lot 2: 1 part of rolled barley to 3 parts of skim milk by weight.
- Lot 3: rolled barley, raisins, and tankage, fed in separate self-feeders.
- Lot 4: 1 part of rolled barley to 3 parts of buttermilk by weight.
- Lot 5: 3 parts of barley, 1 part of raisins, and 12 parts of skim milk, by weight.
- Lot 6: 3 parts of barley, 1 part of raisins, and 12 parts of buttermilk, by weight.

Results.—An examination of table 4 discloses the fact that all except lot 3 gained more rapidly than did lot 1, which was fed rolled barley and tankage. The addition of raisins to a ration of rolled barley and tankage (lot 3) reduced the rate of gain and increased the amount of feed required for 100 pounds of gain. The pigs in lot 3, self fed barley, raisins, and tankage, consumed about 80 per cent as much raisins by weight, as barley. A comparison of lot 2 (fed barley and skim milk), with lot 4 (fed barley and buttermilk), shows the former gained more rapidly and a slightly smaller amount of feed was required for 100 pounds of gain. Lots 5 and 6 required about the same amount of feed for 100 pounds of gain and experienced about the same rates of gain.

TABLE 4
SUMMARY OF RESULTS OF THIRD TRIAL

Lot No.	Ration	Average initial weight	Average final weight	Average daily gain	Feed consumed for 100 pounds of gain
1	Rolled barley.....	Pounds	Pounds	Pounds	Barley, 388.99
	Tankage.....				Tankage, 49.86
2	Rolled barley.....	77.5	187.4	1.57	Barley, 282.13
	Skim milk.....				Milk, 582.90
3	Rolled barley.....	77.1	206.9	1.85	*Tankage, 7.86
	Raisins.....				Barley, 276.56
4	Raisins.....	78.5	175.1	1.38	Raisins, 194.90
	Tankage.....				Tankage, 53.59
5	Rolled barley.....	77.8	198.3	1.72	Barley, 307.05
	Buttermilk.....				Buttermilk, 557.76
6	Rolled barley.....	78.8	199.3	1.72	*Tankage, 8.51
	Raisins.....				Barley, 232.47
	Skim milk.....				Raisins, 77.49
	Rolled barley.....	76.8	200.4	1.77	Milk, 634.73
	Raisins.....				*Tankage, 9.20
	Buttermilk.....				Barley, 241.17
					Raisins, 80.39
					Buttermilk, 581.64
					*Tankage, 9.12

* Tankage fed because dairy by-products were unavailable for a time.

During this trial, whenever skim milk or butter milk was fed instead of tankage, the rate of gain was increased, and the amount of concentrates required for 100 pounds of gain was decreased.

FOURTH TRIAL

Since the feeding in the second and third trials was done in dry lot, it was thought best to conduct similar feedings on alfalfa pasture before presenting definite conclusions. In this fourth trial four lots of twelve pigs each, farrowed in March and April, 1924, were self fed

raisins and other feeds on alfalfa pasture. Each lot had the run of one-half acre of good alfalfa pasture. The trial began July 28, 1924. Lot 1 was fed for 98 days; lots 2, 3, and 4 for 70 days. The pigs were a very uniform lot of purebred Poland-Chinas, well-grown but not fat.



Fig. 1.—Purebred Poland-Chinas at the beginning of the fourth trial, showing uniformity and thrift of the pigs and the character of the alfalfa pasture.



Fig. 2.—The same pigs at the close of the fourth trial, indicating uniform size and excellent condition. The alfalfa pasture still shows considerable growth.

Rations.—The rations fed were as follows:

Lot 1: 15 parts of raisins and 1 part of tankage, by weight, mixed and self fed, and alfalfa pasture.

Lot 2: 7½ parts of raisins, 7½ parts of rice bran, and 1 part of tankage, by weight, mixed and self fed, and alfalfa pasture.

Lot 3: 5 parts of raisins, 5 parts of rolled barley, 5 parts of rice bran, and 1 part of tankage, by weight, mixed and self fed, and alfalfa pasture.

Lot 4: 15 parts of rolled barley and 1 part of tankage, by weight, mixed and self fed, and alfalfa pasture.

Results.—The pigs in lot 1 (see table 5) gained very slowly as compared with those of the other lots and were not as well finished at the end of a 98-day feeding period as the others at the conclusion of a 70-day period. Moreover, they consumed more feed than any other lot, and scoured somewhat throughout the test.

TABLE 5
SUMMARY OF RESULTS OF FOURTH TRIAL

Lot No.	Ration	Feeding period	Average initial weight	Average final weight	Average daily gain	Feed consumed for 100 pounds of gain
1	Raisins, 15.0 Tankage, 1.0	Days 98	Pounds 82.11	Pounds 163.72	Pounds 0.832	596.84 (mixture)
2	Raisins, 7.5 Rice bran, 7.5 Tankage, 1.0	70	81.39	185.22	1.483	470.0 (mixture)
3	Raisins, 5.0 Rolled barley, 5.0 Rice bran, 5.0 Tankage, 1.0	70	82.28	205.09	1.76	436.29 (mixture)
4	Rolled barley, 15.0 Tankage, 1.0	70	82.95	198.83	1.66	385.18 (mixture)

The addition of rice bran to a ration of raisins and tankage (lot 2) resulted in an increase in the average daily gain. The amount of feed required for 100 pounds of gain was less.

The pigs in lot 3 made the most rapid gains of all of the lots. The addition of rolled barley to a ration of raisins, rice bran, and tankage also resulted in reducing the amount of feed required for 100 pounds of gain.

While lot 4 did not gain so rapidly as lot 3, they required less feed for 100 pounds of gain than did any of the other lots.

The results of this trial indicate that a ration of raisins and tankage on alfalfa pasture was not altogether satisfactory. The addition of raisins and rice bran to a barley and tankage ration on alfalfa pasture would be a satisfactory practice.

FIFTH TRIAL

On August 5, 1924, a group of 84 pigs bred and raised at the University Farm and farrowed in March and April, 1924, were divided into two lots of 42 pigs each and were fed for 91 days. The trial was concluded and final weights taken November 4, 1924. Lot 1 was fed in dry lot and lot 2 on alfalfa pasture.

Rations.—The rations for the lots were as follows:

Lot 1: equal parts of rolled barley, raisins, and rice bran, mixed and fed in self-feeder, and tankage fed in a separate self-feeder.

Lot 2: equal parts of rolled barley, raisins, and rice bran, mixed and fed in self-feeder, tankage fed in a separate self-feeder, and alfalfa pasture.

TABLE 6
SUMMARY OF RESULTS OF FIFTH TRIAL

Lot No.	Number of pigs in lot	Ration	Average initial weight	Average final weight	Average daily gain	Feed consumed for 100 pounds of gain
			Pounds	Pounds	Pounds	
1	42	Rolled barley.....	56.75	153.93	1.068	{ Mixture, 483.10 Tankage, 30.67
		Raisins.....				
		Rice bran.....				
		Tankage.....				
2	42*	Same as above plus 3 acres alfalfa pasture	56.79	186.58	1.43	{ Mixture, 456.03 Tankage, 6.56

* Only 39 pigs actually finished.

Results.—The addition of alfalfa pasture to a ration of rolled barley, raisins, rice bran, and tankage resulted in more rapid gains; moreover, for each 100 pounds of gain in lot 2 it replaced 27.07 pounds of the mixture (rolled barley, raisins, and rice bran, equal parts by weight), and 24.11 pounds of tankage. The small amount of tankage consumed by the pigs in lot 2 for 100 pounds of gain is noteworthy.

SUMMARY

1. Cull or damaged raisins, a carbohydrate feed carrying a high percentage of sugar, were found to be a palatable feed for swine.
2. Raisins, when fed with barley and some nitrogenous concentrate, produced satisfactory gains and had a value, when fed in this manner, somewhat less pound for pound than rolled barley.

3. The addition of raisins to a barley and tankage ration resulted in a slight increase in total feed required for 100 pounds of gain.

4. Pigs fed raisins and tankage on alfalfa pasture gained very slowly and scoured severely at times. Such a ration is not a satisfactory one when rapid gains are desired.

5. These trials indicate that less barley is required for 100 pounds of gain and that the rate of gain is usually more rapid when dairy by-products constitute the nitrogenous supplement than when tankage is used for this purpose.

6. A ration of rolled barley 15 parts, tankage 1 part, by weight (see table 6), with alfalfa pasture in addition, proved more efficient in the amount of feed consumed for 100 pounds of gain than a ration of rolled barley 5 parts, raisins 5 parts, rice bran 5 parts, and tankage 1 part by weight. The average daily gain, however, was less.

7. Alfalfa pasture was a valuable addition to a ration of barley, rice bran, raisins, and tankage.